COST ACTION 633

Particulate Matter: Properties Related to Health Effects

Modelling PM in Europe

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PORTUGAL

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Air Quality Models to...

... simulate the

- **transport**
- **chemical transformation**
- **deposition of air pollutants**

... more recently formation of secondary particles from gaseous precursors and particles dynamics

What kind of models?

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There are different models for different applications !!!

According to mathematical approach

- analytical models (gaussian type models)
- statistical models (diagnostic models)
- numerical models (prognostic models: eulerian, lagrangean).

According to air pollution problem

- **spatial scale**: global, regional, mesoscale, urban, local, microscale
- **temporal scale**: short-term, seasonal, long-term
- **chemical reactions**: passive dispersion, photochemical, ...

but computer capacity and experts are also important

As much complex is the model better results could provide, however more resources are needed!!!

What are the model inputs and outputs?

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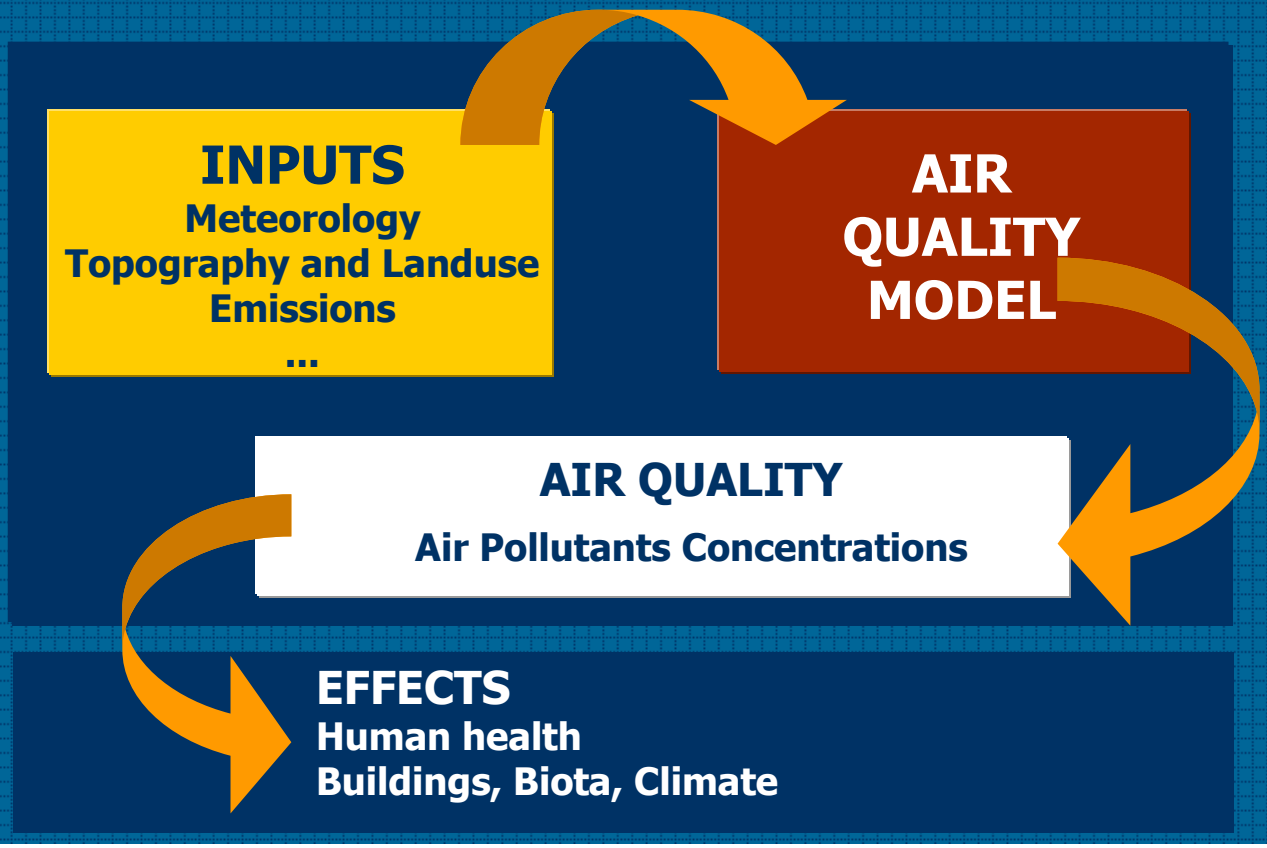

Regional Models – some examples

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- Danish Eulerian Model DEM
  http://www.dmu.dk/AtmosphericEnvironment/DEM
- European Air Pollution Dispersion EURAD/FFA
  http://www.eurad.uni-koeln.de
- European Operational Smog EUROS
- Long Term Ozone Simulation LOTOS
- Multi-scale Atmospheric Transport and Chemistry MATCH
  http://www.smhi.se/sgn0106/if/meteorologi/match.htm
- REM3/CALGRID, Regional Eulerian Model + California Grid Model

Regional scale models

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	DEM	EURAD	EUROS	LOTOS	MATCH	REM3C ALGRID
Aerosol Module						
Size distribution						
In-cloud conversion						
Aerosol dry deposition						
Heterogeneous chemistry – N_2O_5 treatment						
Sub-grid deposition correction						
SOA formation						
Primary organic compound						

Regional Models - EURAD

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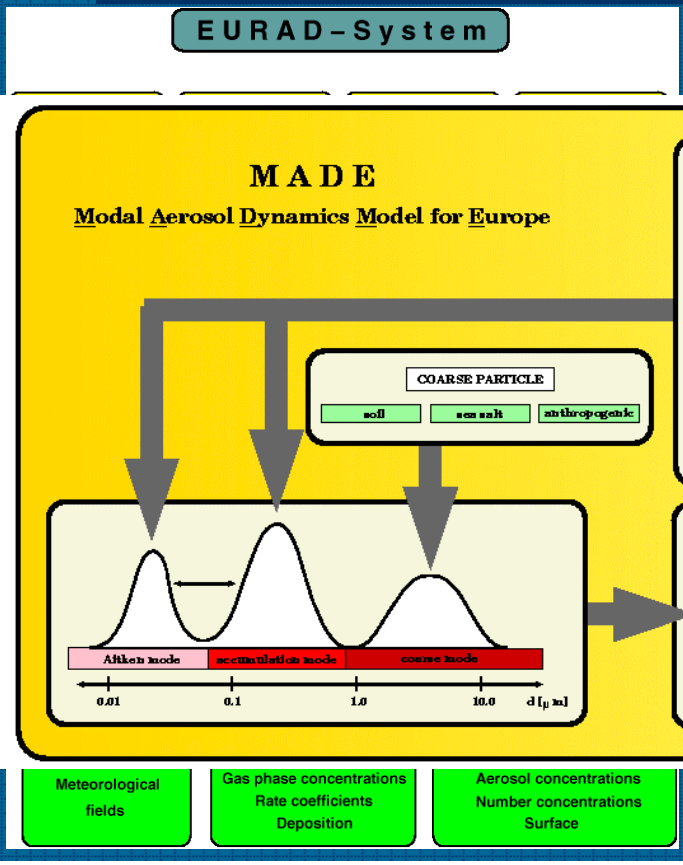

Some Results - EURAD

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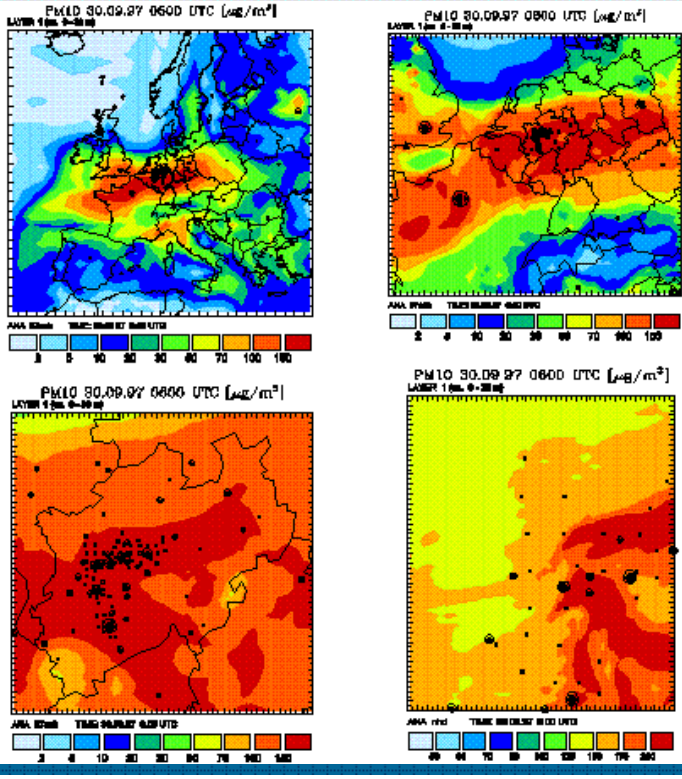
PM10 - NESTING

Sept. 30, 06 UTC, 1997

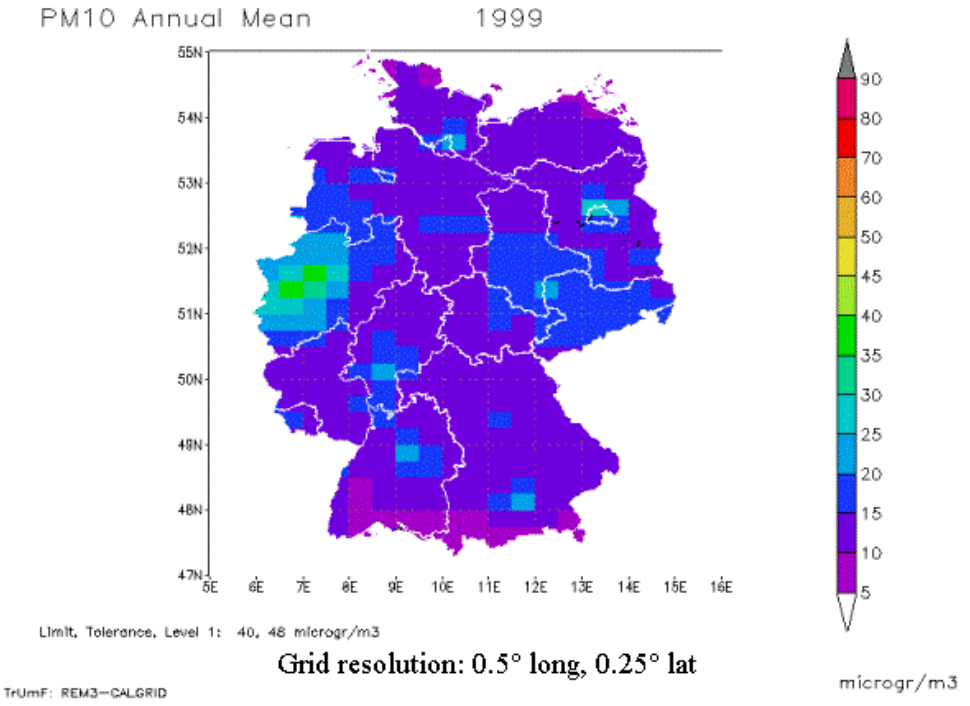
High pressure system over Central Europe

PM10 concentrations exceed 150 μg/m³

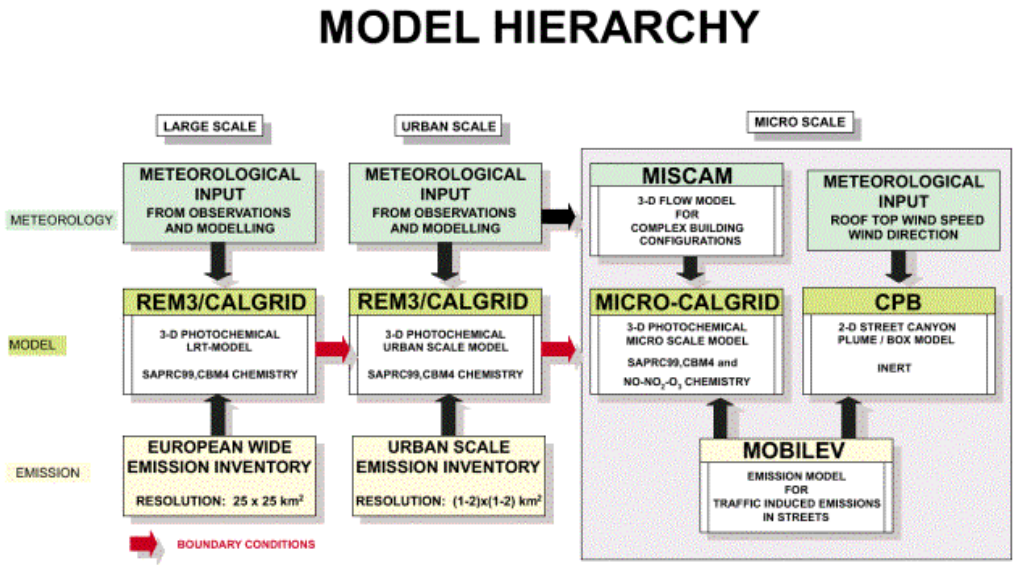
Concentrations for all domains



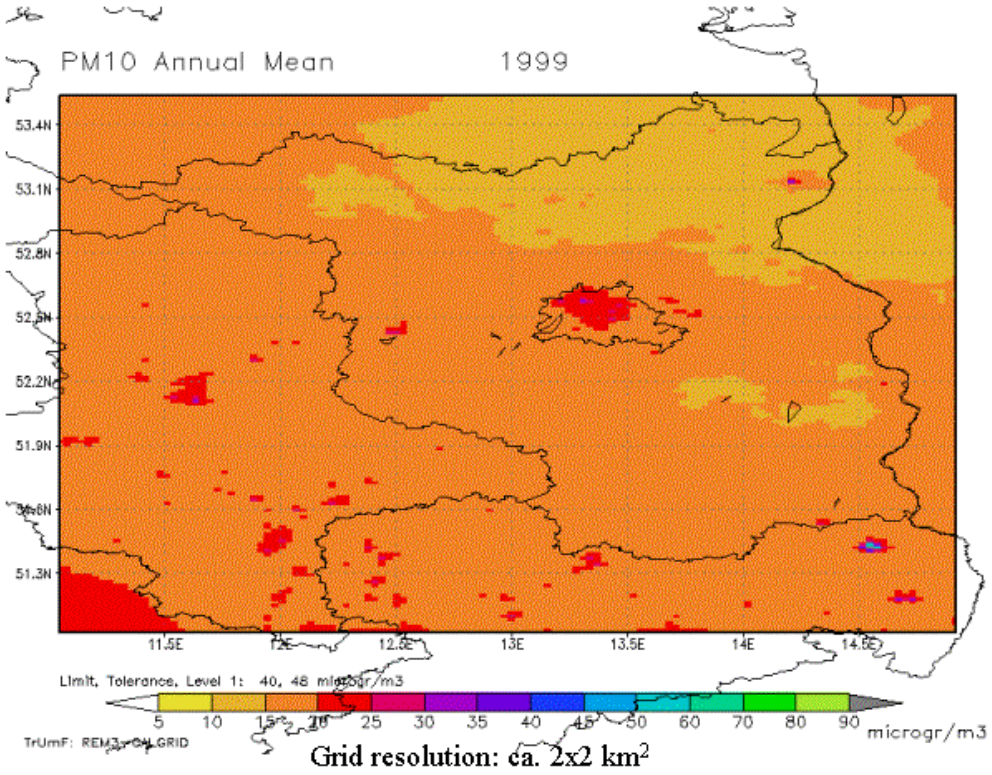
Some Results – REM3/CALGRID



From regional to urban



Some Results – REM3/CALGRID



Grid resolution: ca. 2x2 km^2

PM workshop Berlin Nov 4-6 2002

Urban scale – CITY DELTA

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MAIN SCIENTIFIC OBJECTIVES:

- What is the influence of local versus regional emission (reductions) on health-relevant metrics for fine particles (PM10, PM2.5) and ozone in urban air?
- How are predictions derived from regional models (e.g. with a spatial resolution of 50*50 km) different from predictions obtained with finer resolved models?
- What is the range of agreement between different scale dispersion models on the level of responses to emission changes?

http://rea.ei.jrc.it/netshare/thunis/citydelta/

Urban scale – CITY DELTA

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	Berlin			Copenhagen			Katowice			London			Milan			Paris			Prague		
	5 km	10 km	50 km	5 km	10 km	50 km	5 km	10 km	50 km	5 km	10 km	50 km	5 km	10 km	50 km	5 km	10 km	50 km	5 km	10 km	50 km
THOR	P	P	P	P	P	P	P	P	P	P	P	P									
REM3	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCCM	P	-	P	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-
CHIMERE	P	-	P	-	-	-		-		P	-	P	P	-	P	P	-	P		-	
OFIS	P			-			-			P			P			P			P		
EMEP	-	-	P	-	-	P	-	-	P	-	-	P	-	-	P	-	-	P	-	-	P
LOTOS				-	-	-	-	-	-	-	-	-	-	-	-	P	P	P	-	-	-

http://rea.ei.jrc.it/netshare/thunis/citydelta/

Applications – Mesoscale

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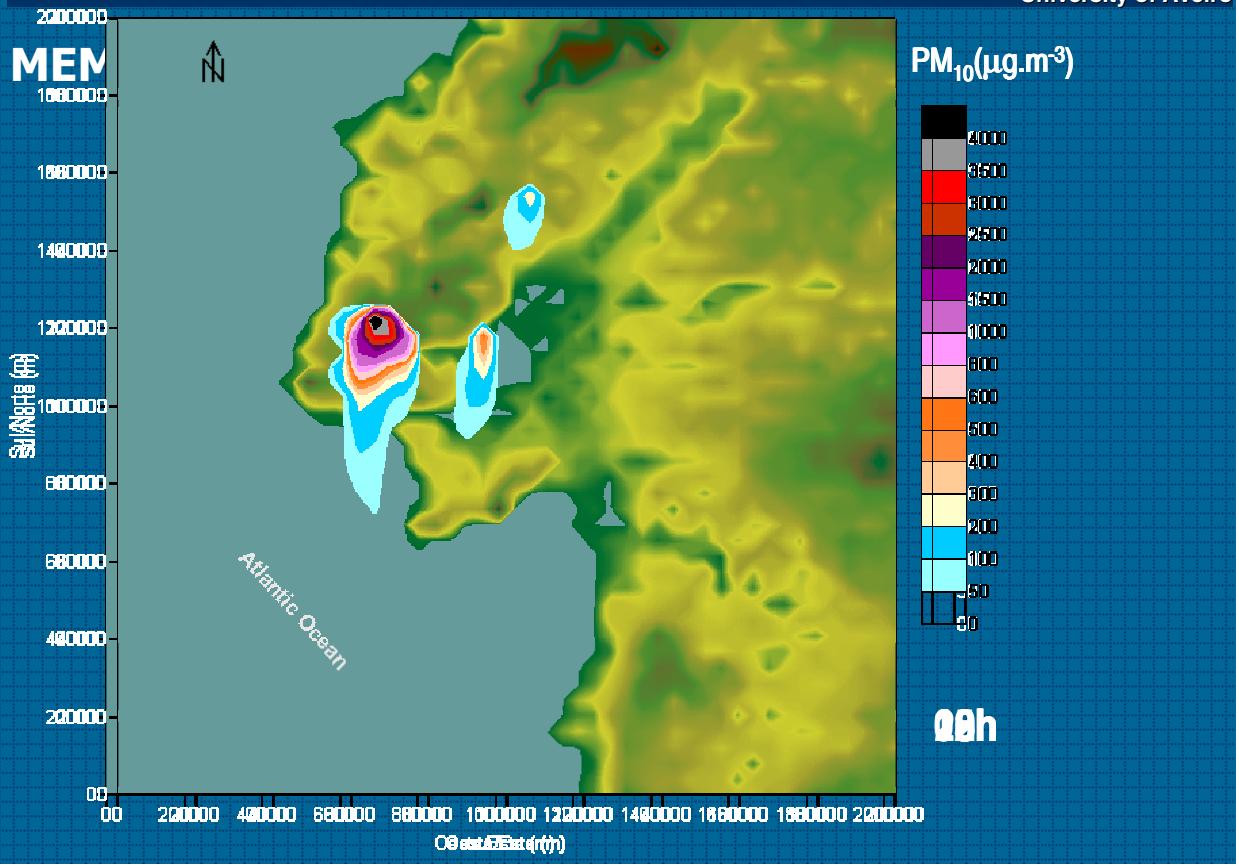
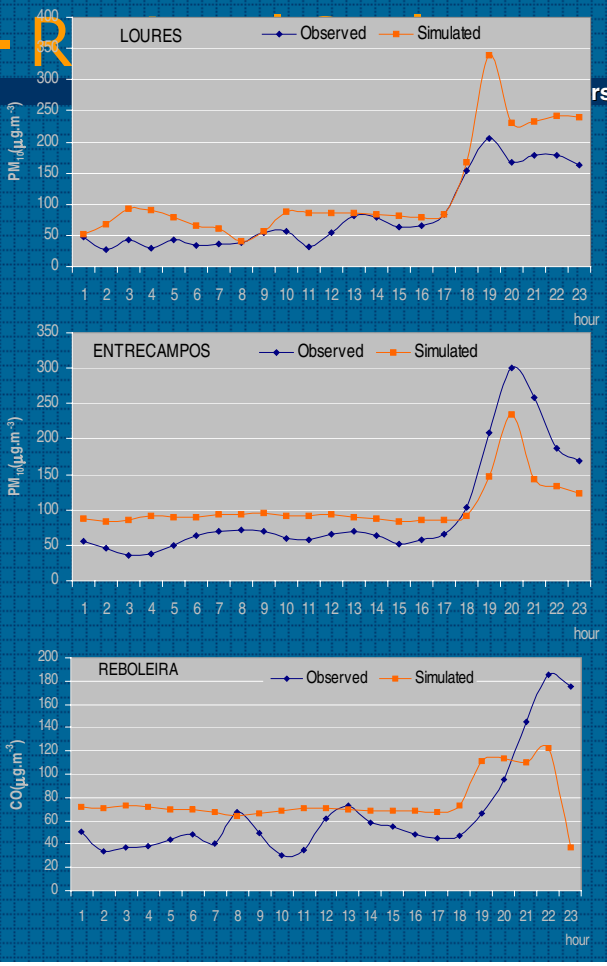


Applications – R

MEMO results and validation– PM



From urban to local scale

mesoscale model → CFD model → population exposure model

define the boundary conditions for the local scale application

CFD model application used for the estimation of hourly PM_{10} concentrations in indoor microenvironments

Local scale modelling

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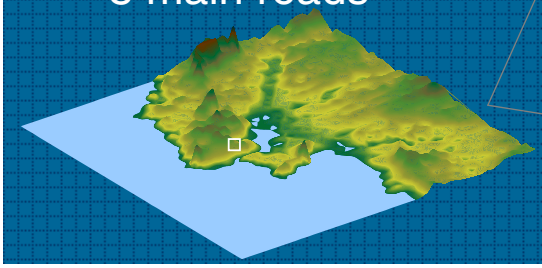
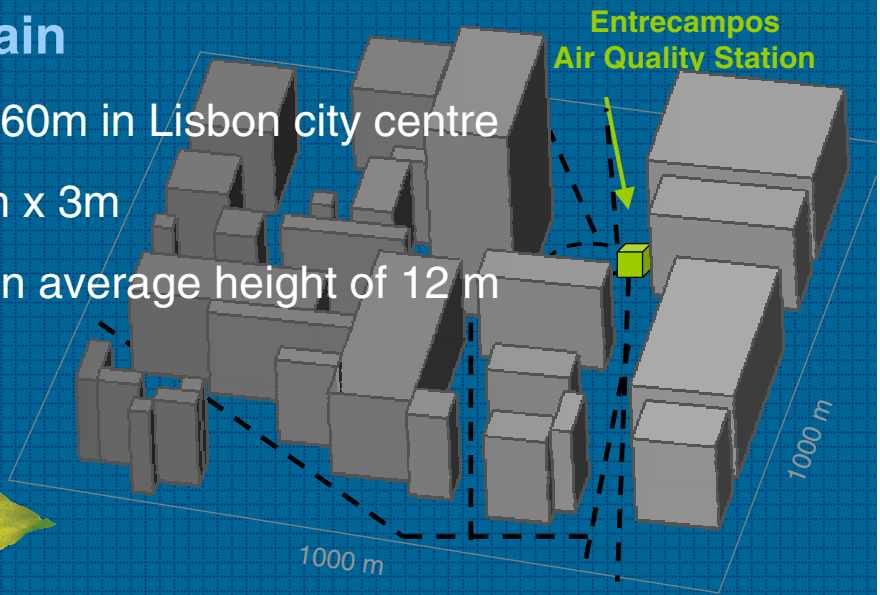
VADIS

CFD model developed at the University of Aveiro

Simulation domain

- 1000m x 1000m x 60m in Lisbon city centre
- resolution 5m x 5m x 3m
- 29 buildings with an average height of 12 m
- 8 main roads





Results and Discussion

mesoscale modelling

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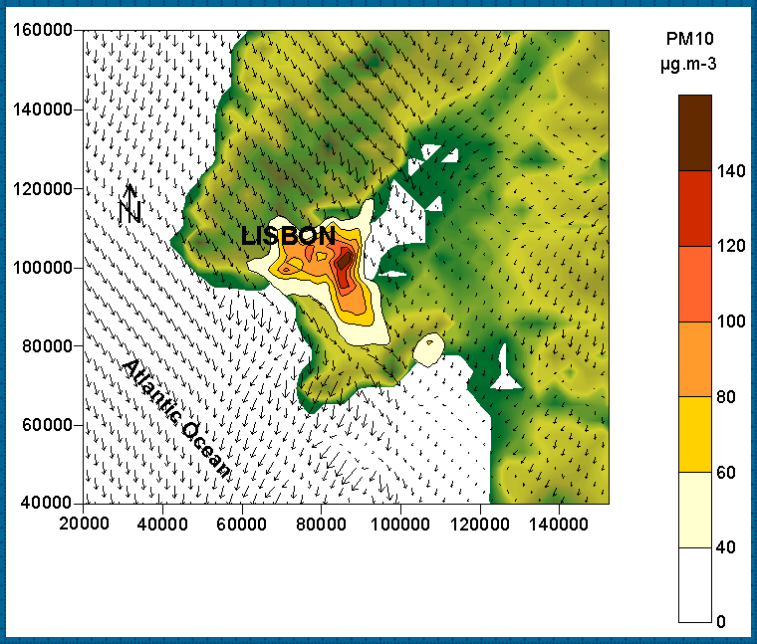

28th of February 2000
9:00

PM10 concentrations reach a maximum of 160 µg.m^{-3}

MEMO-PM results – Wind and PM10 concentration fields at 9:00

Results and Discussion

local scale modelling

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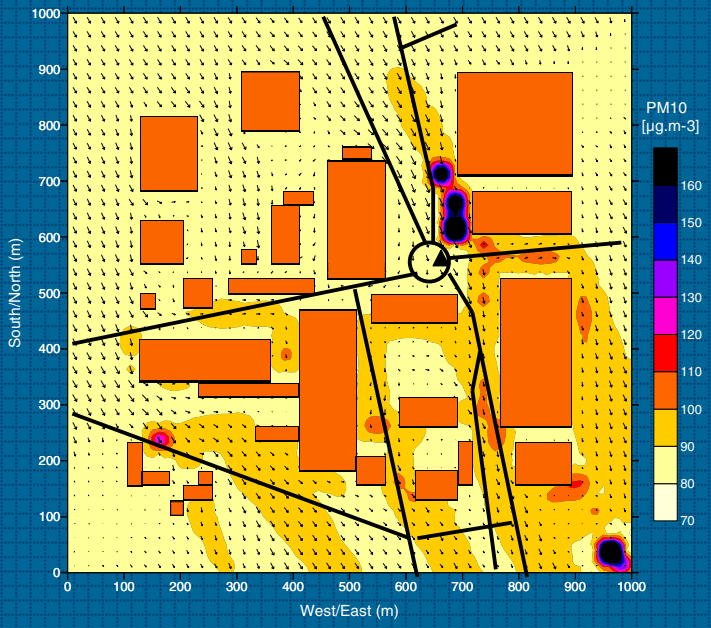

28th of February 2000

9:00

PM10 concentration values inside the domain are above the daily limit value of 50 µg.m^{-3}

▲ Entrecampos air quality station

Road network

VADIS results - Wind and PM10 concentration fields at 9:00

Results and Discussion

population exposure modelling

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APEI50 field for 9:00 with microenvironments distribution

- highest values of APEI50 found in schools and faculties
- high APEI50 values in some office buildings in the vicinity of roads

SEMI-EMPIRICIAL MODELS
(based on PM measurements)

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ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

A semi-empirical model for evaluating urban particulate matter concentrations and comparison of model predictions with data of an urban measurement network

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Air Quality Research, Helsinki, Finland
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Helsinki Metropolitan Area Council (YTV)

Future work

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- Continue the review on PM modelling in Europe
- Understand the needed data

... ???